Trail Design for Access

Chapter 5

Trails provide both recreation and transportation routes through natural environments and urban areas. A wide variety of people with a range of mobility and physical endurance enjoy visiting outdoor trails. Trail users include people with and without disabilities, children, families, and older adults. Trail users participate in a variety of activities, including biking, cross-country skiing, and hiking.

This chapter examines elements and characteristics, such as grade, cross-slope, surface type, and signage, that have the greatest impact on access. Design and user conflicts that result from having multiple user groups on the same trails are addressed as well.

5.1 Universal Trail-Assessment Process

To gain a better understanding of existing trail conditions, the researchers visited several trail and shared-use-path facilities within the United States. During these visits, trail characteristics were measured using the Universal Trail Assessment Process (UTAP). The UTAP was chosen because it collects objective mapping, usage, and maintenance information about trails, as well as information about characteristics that significantly influence user safety and access. It is critical to obtain quantitative information about trail characteristics to determine how access can be improved through maintenance, reconstruction, and/or dissemination of information. The National Park Service, the California State Park System, and the Minnesota Department of Natural Resources are among the land management agencies that have implemented the UTAP in their jurisdictions.

The UTAP utilizes the following simple surveying tools to measure trail characteristics:

- A compass to measure bearing
- A rolatape to measure distance
- A clinometer to measure running grade
- A tape measure to determine width, clearance, and obstacle dimensions
- A level to measure maximum grade, running cross-slope, and maximum cross-slope

The Global Positioning System (GPS) can be used as an alternative to the compass and clinometer to track positioning and elevation. GPS was not used during the sidewalk assessments because it has several drawbacks. These disadvantages include increased expense, reliance on battery power, problems obtaining signals in forested areas or narrow canyons, the requirement to wait before a reading can be obtained, and grade measurements that are significantly less accurate than those obtained by a clinometer (unless a base station providing differential signal correction is used).

5.2 Design Guideline Comparisons

The researchers compiled existing guidelines and recommendations related to trail design and construction. Guidelines published by Federal and State governments, counties, cities, private organizations, and advocacy groups were collected and summarized in Tables 5-4 through 5-9, which are located at the end of this chapter.

Consideration of the needs of bicyclists, pedestrians, people with disabilities, and other user groups differ greatly among guidelines. This variation is primarily due to the mission and constituency that each agency or organization serves. For example, the U.S. Access Board focuses primarily on the needs of people with disabilities, while State DOTs serve a

more varied group of people and might focus on design issues that do not relate to access. Recommendations for trails intended for use by a single recreation group, such as motorcyclists, are sometimes written by advocacy groups such as the American Motorcyclists Association.

Some design guidelines make provisions for different levels of difficulty to provide a variety of trail experiences within a single recreation area. Guidelines and recommendations for trails designed at multiple difficulty levels are represented in the tables as Multiple Levels. These levels are termed Easier, Moderate, and Difficult. If a fourth level of difficulty, equivalent to Most Difficult, was included in a guideline or recommendation, it was not listed in the table. Guidelines and recommendations recognizing only one level of difficulty are represented in the tables as Single Level. The tables are organized by trail type. Abbreviated bibliographical information for each document is included in the Source column of the tables; however, complete bibliographical information is included at the end of this report.

Although trail designers may find it helpful to adhere to guidelines for easier, moderate, and difficult trails during the design process, rating trails as such can be misleading for users. What is considered easier, moderate, and difficult varies between areas and can be hard for users to interpret. Alternatively, conveying the dimensions and magnitudes of trail characteristics to users through signage would provide visitors with reliable and comparable information.

5.3 Trail Types

Trail design guidelines are generally written to accommodate a specific type of user. For example, guidelines developed solely for snow machine use will not meet the needs of a cross-country skier. In practice, most trails are used by more than one type of user and should be considered shared-use paths. Only trails with features and strict enforcement practices that effectively exclude other users are single-user paths. For this reason, the design needs of all potential user groups should be considered when planning a trail.

Guidelines for the following types of paths were compiled and considered in

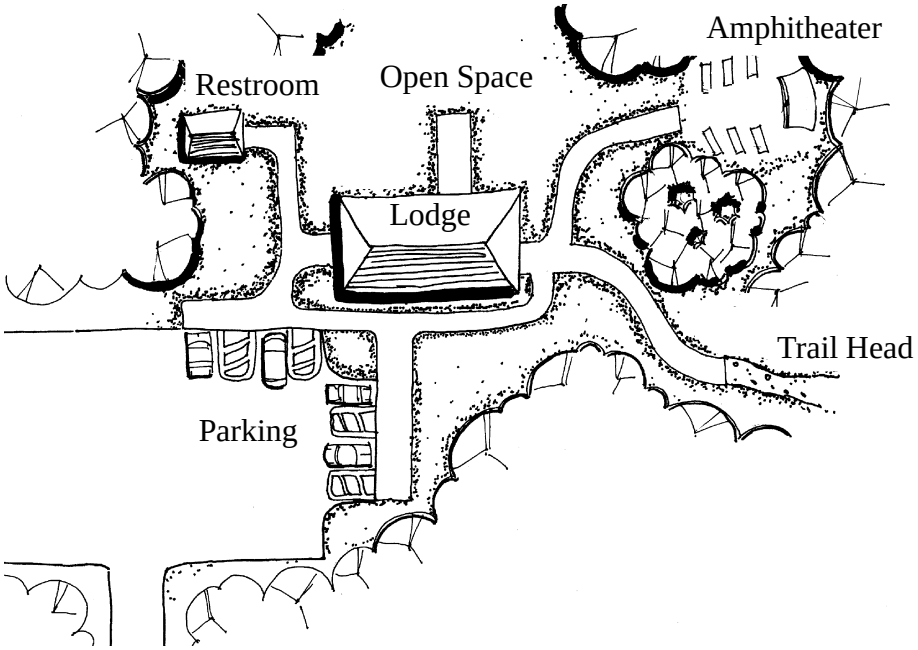


Figure 5-1: Outdoor recreation access routes (ORARs) link accessible elements at a recreation site.

this report; definitions for each are listed in the Glossary (Appendix B):

- Accessible Routes
- Outdoor Recreation Access Routes (Figure 5-1)
- Recreational Trails
- Hiking Trails
- Shared-Use Paths
- Bicycle Paths
- Mountain Biking Trails
- Equestrian Trails
- Cross-Country Ski Trails
- Snow Machine Trails
- All-Terrain Vehicle Trails
- Off-Highway Vehicle Trails
- Motorcycle Trails

5.4 Access Characteristics

5.4.1 Grade

Grade (slope) is defined as the slope parallel to the direction of travel and is calculated by dividing the vertical change in elevation by the horizontal distance covered. For example, a trail that gains 2 m in elevation over 40 m of horizontal distance has a grade of 5 percent. Some guidelines use the term "slope" to refer to grade. However, the term "grade" is used in this report to avoid confusion with cross-slope. *Average grade* is defined as the average of many contiguous running grades. Running grade is usually measured over the maximum distance afforded by sight lines when grades are continuous. However, more detailed grade information can be obtained if measurement distances do not exceed 30 m (100 ft). Running grade is also measured on shorter trail segments between changes on grade. *Maximum grade* is defined as a limited section of trail that exceeds the typical running grade. Maximum grade values can differ significantly from the running grade values. For example, a trail that gains 15 m in elevation gradually over 1 km has the same running grade as a trail that is flat for 0.75 km and then climbs 15 m over the last 0.25 km; however, the two trails make very different strength and endurance demands of users. The steeper segment in Figure 5-2 is an example of a maximum grade that occurs over a short distance and significantly exceeds the typical running grade. Table 5-1 contains

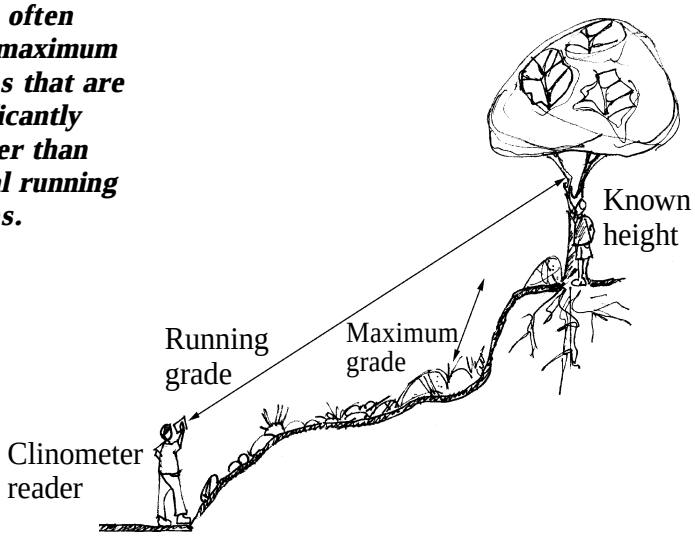
Table 5-1:

Results of 10 Trail Assessments Show That on Many Trails, the Maximum Grade and Cross-Slope Significantly Exceed the Typical Average Grade and Cross-Slope ***(Chesney and Axelson, 1994)***

Trail	Average Grade (%)	Maximum Grade (%)	Average Cross-Slope (%)	Maximum Cross-Slope (%)
Beehive	10	47	9	34
Boiling River	4	62	7	32
Fairy Falls	3	40	10	25
Grotto Falls	4	19	2	12
Ice Lake	3	14	6	9
Kersey Lake	5	70	11	32
Mystic Falls	6	62	9	38
Palisades Falls	10	32	3	14
Pine Creek Falls	8	75	16	47
Wraith Falls	6	42	6	18

Figure 5-2:

Trails often have maximum grades that are significantly steeper than typical running grades.



the typical running grade and the maximum grade from 10 trail assessments. The maximum grade significantly exceed the typical running grade in all 10 examples.

The *rate of change of grade* is defined as the change in grade over a given distance. The rate of grade change is determined by measuring the grade and the distance over which it occurs for each segment of the overall distance. For the purposes of this report, rate of change of grade is measured over 0.610 m (2 ft) intervals, which represent the approximate length of a single walking pace and a wheelchair wheelbase.

In the trail environment, rate of change of grade should not exceed 13 percent. If the rate of change of grade exceeds 13 percent over a 0.610 m (2 ft) interval, the ground clearance of the footrests and or antitip wheels may be compromised. Antitip wheels are placed on the back of some wheelchairs to improve stability and prevent tipping. Even wheelchair users traveling slowly can get stuck if the footrest or antitip wheels get caught.

If the rate of change of grade exceeds 13 percent, the dynamic stability of the trail user can also be significantly compromised, depending on the speed at which the wheelchair user goes through the rapidly changing grade. Dynamic stability is compromised because the negative grade of the first sloped surface causes the wheelchair to rotate forward. However, upon reaching the bottom of the transition, the wheelchair begins to rapidly pitch back as the wheelchair transitions up onto the positive grade of the second sloped surface. Rapid changes in grade can also cause a wheelchair user traveling with speed to flip over backward. Any amount of height transition between the two sloped surfaces can further contribute to problems for wheelchair users.

Most design guidelines provide specifications for maximum allowable running grade over long distances and maximum grade between level areas. Tables 5-4.1 through 5-4.5 list design guidelines for maximum allowable running grade. Tables 5-5.1 through 5-5.5 list design guidelines for maximum grade between level landings.

The recommendations for running grade and maximum grade usually depend on the designated users of the trail. For example, grades up to 25 percent are typically permitted for snow machine trails, while the recommended running grade for Outdoor Recreation Access Routes is only 5 percent. The distances over which maximum grades are permitted to occur also vary by the type of user group. For example, the USDA Forest Service guidelines recommend a 20 percent maximum grade for 30 m (100 ft) on hiking trails, but a 20 percent maximum grade is permitted to extend for 61 m (200 ft) on ATV trails. In some instances, the location of the trail also might impact the running grade. For example, a trail that follows a stream may be permitted to have grades similar to those of the land contours.

Long switchbacks are often recommended in steep terrain to reduce grades (Figure 5-3). The steeper the terrain, the longer the switchbacks should be. In open areas, hikers and other user groups often create way trails to avoid traversing the entire switchback. A way trail is an informal

Figure 5-3:
Well-designed switchbacks reduce the grade of a trail and make hiking easier for people with mobility disabilities.

path that allows users to travel a shorter distance by cutting across the land between the switchbacks. Way trails hasten soil erosion and destroy surrounding vegetation.

Installing landscaping barriers, such as shrubs, along switchbacks is one method to prevent hikers from creating way trails. However, a more cost-effective solution involves choosing switchback points with natural barriers, such as rocks or thick vegetation, as illustrated in Figure 5-3. Wherever possible, trails should be designed on more level terrain to maintain minimum design guidelines for grade and avoid the need for switchbacks.

5.4.2 Rest Areas

Rest areas are defined as level portions of a trail wide enough to provide wheelchair users and others a place to rest and gain relief from prevailing grade and cross-slope demands. Users can benefit from rest stops on steep or very exposed trails to pause from their exertions and enjoy the environment. Rest areas are most effective when placed at intermediate points, scenic lookouts, or near trail amenities. Rest areas located off the trail allow stopped trail users to move out of the way of continuing traffic (Figure 5-4). The most inviting rest areas have a bench, shade, a place to rest bicycles, and a trash receptacle. Water fountains and washroom facilities are also useful on long trails (FL DOT, 1997).

Rest area interval is defined as the distance between rest areas. Most agencies and private organizations that provide recommendations for rest area intervals concur with the 1994 Recreation Access Advisory Committee, which recommends that easier, moderate, and difficult trails should have rest areas at maximum intervals of 121.9 m, 274.3 m, and 365.8 m (400 ft, 900 ft, and 1200 ft), respectively. The California State Parks Guidelines call for rest areas on easier, moderate, and difficult ORARs at maximum intervals of 61.0 m, 121.9 m, and 182.9 m (200 ft, 400 ft, and 600 ft), respectively. The New Mexico Plan specifies 402.5 m (1,321 ft) as the maximum allowable interval between rest areas on difficult trails.

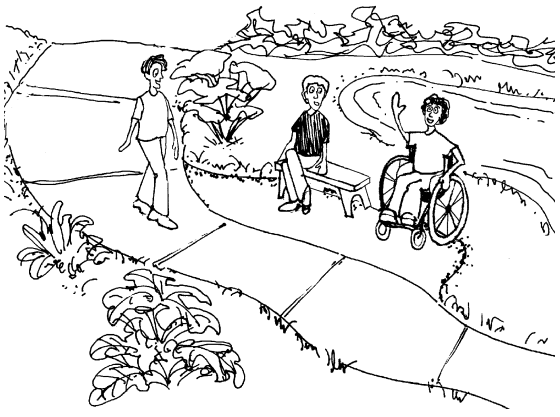
5.4.3 Cross-Slope

Cross-slope is defined as the slope measured perpendicular to the direction of travel. Cross-slope must be measured at specific points. The average cross-slope is the average of cross-slopes measured at regular intervals along the trail. *Running cross-slope* is defined as the average cross-slope of a contiguous section of trail. The running cross-slope can be determined by taking periodic measurements throughout a section of trail and then averaging the values. *Maximum cross-slope* is defined as a limited section of the trail that exceeds the typical running cross-slope of the path.

Rate of change of cross-slope is defined as the change in cross-slope over a given distance. For the purposes of this report, rate of change of cross-slope was measured over 0.610 m (2 ft) intervals, which is the approximate length of a single walking pace and the wheelbase of a wheelchair. Rate of change of cross-slope can be measured by placing a level 0.610 m (2 ft) before and after a

Figure 5-4:

Rest areas enhance the trail for all users.



maximum cross-slope. Rapidly changing cross-slopes can cause one wheel of a wheelchair or one leg of a walker to lose contact with the ground and also can cause walking pedestrians to stumble or fall.

A summary of the guidelines and recommendations for running cross-slope can be found at the end of the chapter in Tables 5-6.1 through 5-6.5. Most of the trail design specifications address maximum allowable running cross-slope but do not address maximum cross-slope for short distances. Table 5-1 contains the average and maximum cross-slope from 10 trail assessments. The maximum cross-slope significantly exceeds the average cross-slope in all 10 examples. Some trail users, including people in wheelchairs, may have difficulty negotiating extreme cross-slopes even for short distances. To address this concern, Axelson, Chesney, and Longmuir (1995) made recommendations for both average and maximum cross-slope. The recommendations differ from the majority of existing recommendations because they suggest maximum average grades and cross-slopes rather than maximum running grades and cross-slopes. On easier ORARs, they recommend a maximum cross-slope of 5 percent for a distance of 3.050 m (10 ft); and on easier recreational trails they recommend a maximum cross-slope of 5 percent for 3.660 m (12 ft).

The accessibility guidelines and most State guidelines for ORARs, access routes, recreational trails, and hiking trails require running cross-slopes that do not exceed 2 percent; however, some nongovernmental organizations recommend cross-slopes that exceed 2 percent. For example, Rathke and Baughman (1994) specify a maximum running cross-slope of 4 percent for hiking trails. Plae, Inc. (1993) and the Recreation Access Advisory Committee (1994) recommend a maximum running cross-slope of 3 percent for easy-level ORARs and recreational trails.

Table 5-2 contains the *AASHTO Green Book*'s specifications for cross-slopes based on surface type. According to the *AASHTO Green Book*, a 1.5 percent cross-slope provides effective drainage in most weather conditions for surfaces with the highest pavement standards. Intermediate and low surface types, such as gravel, may require larger cross-slopes to enable adequate drainage (AASHTO, 1995).

Table 5-2:

Cross-Slope Ranges by Surface Type (AASHTO, 1995)

Surface Type	Cross-Slope Range
High (highest pavement standard)	1.5–2.0%
Intermediate (slightly below high)	1.5–3.0%
Low (loose surface; earth, gravel, etc.)	2.0–6.0%

A recently conducted pilot study has concluded that adults with and without disabilities are unable to distinguish between 2 and 3 percent cross-slopes (Axelson, Chesney, and Longmuir, 1995). Maintaining minimal cross-slope values can significantly increase the cost and environmental modifications required to build trails on steep terrain.

5.4.4 Width

Two measurements, the *design width* and the *minimum clearance width*, are used to characterize trail width. *Design width* is defined as the width specification the trail was intended to meet. Some guidelines refer to design width as tread width. Some agencies recommend clearing brush from an area wider than the design width. *Minimum clearance width* is defined as the narrowest point on a trail. A minimum clearance width is created when the actual "usable surface" of the trail is substantially smaller than the full trail width. This can result from obstacles such as trees

protruding into the trail and reducing the clear space or from a reduction in the design width.

Trail features such as large rocks and fallen trees can be obstacles to trail users if they limit the passage space (the vertical clear space or clear width) of the trail. Although some obstacles might not impede a hiker or equestrian, they might impede the progress of those using strollers, wheelchairs, walkers, snow machines, or off-highway vehicles. Maintenance, reconstruction, and signage posted on the trail can help visitors avoid frustration and potential safety hazards when encountering obstacles such as a landslide that blocks a portion of the trail.

The types of user groups permitted on a trail affect its optimal design width. In general, the faster a user travels, the wider the trail must be to accommodate turns and limit collisions. For example, snow machines can attain speeds equivalent to those of automobiles and require the widest types of trails. Other user groups capable of faster travel than most pedestrians include OHVs, motorcycles, ATVs, bicyclists, equestrians, skaters, and skateboarders. Trails that accommodate such fast-moving technologies may be made narrower to increase the challenge to users, as with single-track mountain bike trails, or to limit user speed. However, more trail crashes and conflicts might occur on narrow trails if users travel fast despite width limitations.

The movement patterns of user groups also affect the design width of a trail. For example, skaters use a lateral foot motion for propulsion that is wider than the stride of most pedestrians. The width required to accommodate this motion increases when skiers and skaters wish to ascend grades or pick up speed. As a result, trails permitting these user groups should be wider than trails that permit only pedestrians.

Guidelines for minimum clearance width are presented in Tables 5-7.1 through 5-7.5, located at the end of this chapter. Many guidelines do not include recommendations for minimum clearance width. Guidelines that do address minimum clearance width generally concur with ADAAG, which specifies 0.915 m (36 in) of clear space (the passage space required for a wheelchair user) (ADAAG, U.S. Access Board, 1991).

5.4.5 Passing Space

Passing space is defined as a section of path wide enough to allow two wheelchair users to pass one another or travel abreast. *Passing space interval* is defined as the distance between passing spaces. Accessible passing spaces allow two wheelchairs to pass one another, or for one wheelchair user to turn in a complete circle. Passing spaces are recommended at regular intervals when the trail is narrow for long distances.

Many agencies and private organizations do not provide guidelines or recommendations for passing space or passing space intervals because their design width specifications are usually wide enough to allow for users to pass one another. Most guidelines that do address passing space concur with ADAAG's guidelines for accessible routes, which specify a passing space of at least 1.525 m x 1.525 m (60 in by 60 in) whenever an accessible route provides less than 1.525 m (60 in) of clear space. According to ADAAG, a T-intersection of two walkways is also an acceptable passing space (ADAAG, U.S. Access Board, 1991).

5.4.6 Changes in Level

Changes in level are vertical height transitions between adjacent surfaces or along the surface of a path. Ruts caused by weather erosion, tree roots

Figure 5-5:
Tree roots that break up the surface of the trail should be removed because they can cause users to trip.

(Figure 5-5), and rocks protruding from the trail surface are common sources of changes in level on trails. Trails with surface materials such as soil and crushed rock almost always have small changes in level. Changes in level can cause many difficulties for people with mobility impairments, such as cane or crutch users. Many cane and crutch users have difficulty lifting their feet high up off the ground, and abrupt changes in level can cause them to trip or fall. People using wheeled devices such as bicycles, wheelchairs, and scooters can easily catch their wheels in small changes in level, which can cause them to tip over.

Guidelines for changes in level are listed in Tables 5-8.1 through 5-8.5, located at the end of this chapter. The ADA Standards for Accessible Design and UFAS permit changes in level of less than 6 mm (0.24 in) to be vertical but changes in level between 6 mm (0.25 in) and 13 mm (0.5 in) to have a 50 percent bevel (US DOJ, 1991; UFAS, US DoD et al., 1984). An accessible ramp is required for changes in level that exceed 13 mm (0.5 in). Some States and private organizations allow vertical changes in level up to 13 mm (0.5 in).

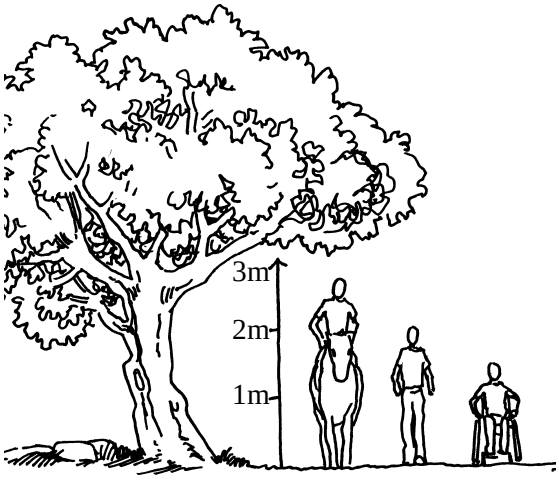


Figure 5-6:
The vertical clearance of a trail should depend on the designated user groups.

5.4.7 Vertical Clearance

Vertical clearance is the minimum unobstructed vertical passage space required along a trail. Guidelines and recommendations for vertical clearance are contained in Tables 5-9.1 through 5-9.5, located at the end of this chapter. Specifications for vertical clearance vary depending on the designated trail users (Figure 5-6). For example, guidelines for trails that permit equestrians typically specify a vertical clearance of 3.050 m (10 ft), while trails that permit only hikers typically require a vertical clearance of 2.030 m (80 in). Because cane or crutch users might have difficulty ducking under vertical obstructions, sufficient vertical clearance is necessary to allow them to remain upright while proceeding along a trail. The height of the average blanket of snow added each winter should also be taken into account for trails that allow cross-country skiing and snow machining.

5.4.8 Surface

The surfacing material on a trail significantly affects which user groups will be capable of negotiating the path. Soft surfaces, e.g., sand and gravel, are

more difficult for all users to negotiate (Figure 5-7). They present particular hazards for those using wheeled devices such as road bicycles, strollers, and wheelchairs not designed for outdoor terrain. In contrast, unpaved surfaces might be preferred by equestrians and runners to prevent excessive jarring of the joints and skeleton. Others, such as mountain bikers and off-road wheelchair users, often prefer unpaved surfaces for the thrill and challenge of negotiating rough terrain.

Figure 5-7:
Soft surfaces are difficult for people with mobility impairments to negotiate and therefore should be avoided.

Local conditions also determine the choice of trail surfaces. Recreational trail surfaces are most commonly composed of naturally occurring soil; however, surfaces ranging from concrete to wood chips may be used depending on the designated user types, the anticipated volume of traffic, the climate, and the conditions of the surrounding environment. High-use trails passing through developed areas and fragile environments are commonly surfaced with pavement, crushed rock, or soils mixed with stabilizing agents to minimize the impact of human traffic on the path.

Locations where the surface changes unexpectedly can frustrate or even endanger trail users unable to negotiate the new surface. This is especially critical in areas where surface conditions change dramatically, i.e., from a paved trail to a sandy beach. Providing information about surface changes through signage or other trail guide products can help visitors avoid such problems.

5.4.9 Trail Information

People select trails based on a variety of criteria, including personal interest, destination, environment, and desired difficulty. Accurate and detailed trail information can provide users with sufficient data to choose routes appropriate to their skill level and desired experience. Trail information can be provided in many formats, including signs, maps, computer programs, posters at park information stations, audio descriptions, and published travel guides. Trail information has traditionally been limited to the trail length, elevation change, usage rules, destination, and descriptive information about points of interest. Signage that provides objective and detailed information about potential obstacles, surface type, grade, cross-slope, and other trail features further benefits users by allowing them to accurately assess whether or not a trail meets their personal level of safety, comfort, and access. Trail users with visual impairments benefit from signs with large lettering, Braille panels, raised lettering, or audio boxes that play prerecorded trail information at the push of a button.

According to ADAAG, “Letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10.” ADAAG also indicates that the letters and numbers of signs designating permanent locations, such as the woman or man indicators on a bathroom door, be raised 0.8 mm (0.03 in) from the surrounding surface and be in upper case, sans serif, or simple serif type. Type should always be accompanied by Grade 2 Braille. The background color of a sign should contrast with the color of the lettering (ADAAG, U.S. Access Board, 1991). Signs should not be placed

in locations where they obstruct the minimum clearance width or vertical clearance of the trail.

The MUTCD references the *Standard Alphabets for Highway Signs and Pavement Markings,* which permits a series of six letter types on signs. Each letter type features a different-stroke width-to-height ratio (Office of Traffic Operations, FHWA, 1982). Various sign, shapes, colors, and lettering are reserved for different types of information such as warnings, destinations, and regulatory functions. The MUTCD does not address the use of Braille and raised lettering (US DOT, 1988).

In a report to the U.S. Access Board, the Recreation Access Advisory Committee recommended that trail type and difficulty level be displayed for all ORARs and recreational trails. The Committee further recommended that maps and signage be provided to users with information on running and maximum grade, maximum cross-slope, minimum trail width, surface type, and magnitude of obstacles (Recreation Access Advisory Committee, 1994).

Trail signs should be appropriate for the environment in which they are located. For example, recreational trails could provide signs on wooden posts to meet user expectations of a "natural" environment.

5.4.10 Maintenance

Trail maintenance keeps trails at or near constructed or intended conditions. Regular trail maintenance can enhance visitor safety, protect resources, and provide continued access to the public.

Regular inspections to identify public safety issues, routine maintenance needs, and resource management problems help ensure that trails remain safe, accessible, and in good condition. Once problems are identified, managers can schedule corrections through a maintenance program.

A system to assess and catalog problems on trails can be used to obtain a comprehensive list of potential maintenance items. All human-built structures on the trail, such as bridges and retaining walls, should be inventoried. The structural integrity and general condition of all features may be assessed at the same time as needed repairs, upgrading, or replacements are recorded. The inspection may include an analysis of the trail surface conditions to identify and measure the extent of entrenchment, drainage, and obstacle problems. A comprehensive list of maintenance items also helps trail managers prioritize and budget for trail repair and improvement projects. When a trail is severely deteriorated, rerouting might be the best alternative to attempting maintenance.

Trail maintenance activities entail a number of preventative and corrective actions (Beers, 1993):

1. Checking the structural integrity of trail features, such as bridges, steps, and railings, and repairing damages.
2. Keeping the tread surface free of obstacles or hazards, such as downed trees and landslides. Loose rocks and earth in a disturbed area should be removed and the trail tread restored to its intended state.
3. Clearing and maintaining drainage features to minimize trail erosion and environmental damage. Drainage methods causing the least impact on the natural environment should be used. In order of least to most damaging, these methods include clearing drainage channels, maintaining outslope of the trail bed, cleaning drain dips or water bars, clearing parallel ditches, and cleaning culverts through or beneath the trail.
4. Cutting vegetation to define the established trail tread and/or protect resources adjacent to the trail.
5. Maintaining the tread in a condition that can be negotiated by trail users.

Tread maintenance can include restoring sloped or crowned surfaces to facilitate drainage, extending the trail back to its original width, filling ruts and holes, and restoring raised approaches to bridges.

5.5 Design Conflicts

The many types of users and varied terrain along which trails are constructed can place competing demands upon trail designers. To minimize impact on the environment while maintaining user safety and avoiding potential user conflicts, trail designers must understand how design specifications affect user interactions and activities. The following discussions provide examples of design conflicts that can occur in trail environments.

5.5.1 Trail Elements

The scope and design of trail elements, e.g., bridges and water bars, should be appropriate to the conditions of the trail and the needs of the full range of users. The accessibility and safety of a trail might be significantly compromised if trail elements do not provide a level of accommodation consistent with the surrounding environment. For example, a trail user negotiating a paved, level path would expect to use an accessible bridge, not a fallen log, when crossing a stream (Figure 5-8). When a trail element along an accessible trail is not consistent with the trail's overall design, a user might be forced to turn back in frustration before reaching his or her destination. If the trail user chooses not to turn back and attempts to continue along the path, he or she risks possible injury.

5.5.2 Built Facilities Along Trails

People with disabilities participate in all types of trail activities at a wide range of skill levels. For example, a person with a mobility impairment might be an advanced horse rider. In addition, a person with a mobility impairment might use a mechanical device, such as an ATV, to reach trail segments that would not ordinarily be accessible to him or her.

It is critical that built facilities, such as restrooms and parking lots at the trailhead and along the trail, be accessible, to address the reality that people with disabilities use all types of trails. ADAAG provides scoping requirements for all built facilities along an accessible route, including restrooms, drinking fountains, and parking lots. The number of accessible spaces required in parking lots, for example, is listed in Table 5-3. All new or remodeled

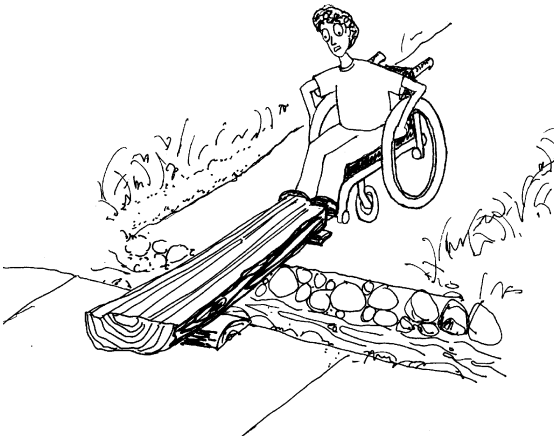
Table 5-3:

Scoping Requirements for Accessible Parking Spaces

Total Parking in Lot	Required Minimum No. of Accessible Spaces
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1000	2 percent of total
over 1000	20 plus 1 for each 100

Figure 5-8:

If a trail is accessible, the trail elements along the path also should be accessible.



built trail facilities provided along a trail or at the trailhead should be built to ADAAG specifications, regardless of the user types permitted or the difficulty level of the trail.

5.5.3 Designing Trail Amenities for Multiple User Groups

Different types of users have distinct needs for trail amenities. For example, bicyclists might need facilities such as bike racks that are easy to use and highly visible (Ryan, 1993). Equestrians require hitching posts and water troughs near stopping points such as picnic tables. Equestrians also need staging and rest areas large enough to accommodate the movements of a horse (ibid.). OHV users require a testing circle, or "landing," to determine if their equipment is operating correctly. The needs of all user groups should be included during the development stage of a trail facility to ensure that adequate amenities are available.

Figure 5-9:

Rubber waterbars are difficult for wheelchair users and bikers to push down traveling uphill, but they are still more desirable than inflexible waterbars.

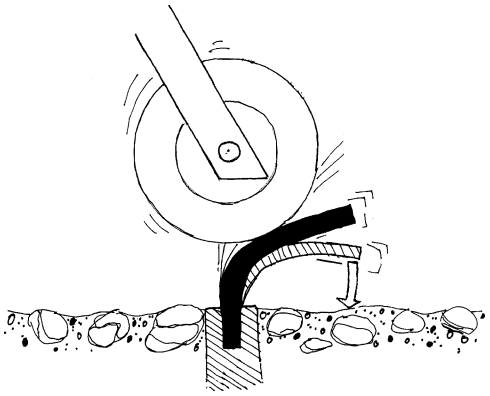
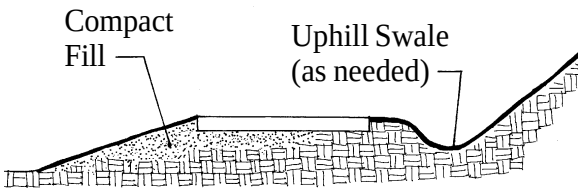


Figure 5-10:

Swales can control drainage and eliminate the need for waterbars.



5.5.4 Drainage Control Measures and Access

Excessive water on a trail can significantly limit trail use, creating conditions harmful to the trail and hazardous to the user. In addition, excess water accelerates erosion and damages the trail surface. Users seeking to avoid the wet conditions might trample adjacent vegetation or cut damaging way trails.

Some cross-slope is needed along a trail to allow water to drain off the path. However, excessive cross-slopes are difficult for people with mobility disabilities to negotiate. For more information on cross-slope, refer to Section 5.4.3.

Drainage bars are often used to encourage the flow of water off the trail. The presence of drainage bars can significantly impact access for trail users. Drainage bars consist of rock, wood, or rubber structures placed across the trail tread to divert water off the trail on steep slopes. All drainage bars can be difficult for people using wheelchairs and other wheeled devices to cross. However, thin rubber drainage bars that flex (Figure 5-9) are easier to travel over than drainage bars made of inflexible materials such as rock. Trails where many users are expected to use wheeled devices, such as shared-use paths in urban areas, should never have drainage bars. Wheeled trail users often attempt to travel around the ends of drainage bars rather than over them, cutting a channel that renders the drainage bar ineffective. Swales (Figure 5-10) and drainage channels can provide the same degree of water runoff while affording better access than drainage bars. However, building trails with less extreme slopes is the easiest manner to avoid the need for drainage bars.

Where water flow is consistent, culverts, short sections of boardwalk, or bridging can be provided. Swamps and other areas that drain poorly might be closed during

certain times such as spring thaw. Porous surfacing materials such as gravel, wood chips, or corduroys (logs or rocks laid on or in the path of travel) may be used to improve drainage and mitigate trail erosion.

5.5.5 Complying with Design Standards

Flexibility in applying guideline specifications might be necessary to acknowledge the diversity of outdoor environments. Variations in terrain, changing outdoor conditions, time periods between access and maintenance reviews, and conflicts between design standards for different user groups are among the factors that can affect the implementation of design guidelines. Design guidelines that cannot realistically be met in some natural environments create an unworkable situation for trail designers. In the worst-case scenario, trail designers might feel that meeting rigid guidelines is impossible and ultimately ignore all design recommendations. For this reason, design guidelines for trails are most effective when they contain provisions to address situations when full compliance is not feasible or desirable.

5.5.6 Difficulty Ratings for Trails

Subjective trail difficulty ratings can be misleading because challenge levels are often determined relative to the trails within a given park or forest area, instead of being based on objective information. As a result, visitors cannot be certain that a trail rated difficult in one area will provide the same challenge as one with the same rating at another area.

Furthermore, most trail rating systems do not allow changes in the design parameters of a trail, and the same difficulty rating can be unrealistic to apply over the full length of a trail. This is especially true for trails that meander through extremely varied terrain. For example, Pine Creek Trail in the Gallatin National Forest in Montana provides access from a campground to a creek, then climbs out of a canyon and across a plateau to a lake. The hike to the creek access is paved and level, requiring approximately 10 minutes to complete, while the rest of the trail is about 8 km long and requires many hours to finish. If considered across its full length, Pine Creek Trail would most likely be categorized as “most difficult,” even though the segment from the trailhead to the creek provides an easier level of access.

Instead of labeling trails with difficulty ratings, trail managers should consider disclosing objective measurement information about trail conditions to visitors. Trail information provided via formats such as signage can convey surface type, grade, cross-slope, and width information. Such information can help visitors determine for themselves which trails will help them achieve their desired experience.

5.6 User Conflicts

When a trail user fails to achieve his or her desired experience from the trip and determines that it is due to someone else’s behavior, conflict results and satisfaction suffers. Conflict is not the same as competition for scarce resources. If people attribute not getting a parking place to their own lack of planning, there is no conflict (Moore, 1994). Conflicts among trail users can stem from a variety of sources, including personal expectations, clashes between different skill levels and speeds, attitudes toward other types of trail users, and intrinsic differences in movement patterns.

5.6.1 Experience Level

Conflicts can arise when trail users with different levels of experience interact

because experts and novices often do not mix well. Skill level affects how well a trail user can maneuver a vehicle or animal. For example, some equestrians might not have sufficient skill to prevent their mounts from running away or kicking other trail users. Similarly, new cyclists might not be aware of the custom of ringing a bell or providing an audible warning before passing other trail users.

The level of intensity at which an activity is pursued also generates user conflicts. For example, fit and experienced bicyclists tend to travel quickly and aggressively. Their approach from behind might frighten less experienced bicyclists.

5.6.2 Expectations

Discrepancies between trail expectations can cause conflicts between users. Many people enjoy trails because they desire a quiet respite from their busy lives. Other people expect an area where they can seek adventure and make noise without disturbing neighbors. When these groups encounter one another on a trail, conflict over expectations often ensues. For example, bird watchers expecting tranquil, undisturbed surroundings might be angry to encounter noise from OHV riders along a trail. Large groups, such as classes of excited schoolchildren, also might disturb other trail users by foiling their expectations of privacy and relaxation. People who view trails as a largely natural environment might become hostile toward trail users who litter or play loud music.

5.6.3 Conflicts Among User Groups

Conflicts on trails most frequently stem from the attitudes of different user groups. Trail users traveling at different speeds and following different movement patterns might clash in attitude and expectation.

5.6.3.1 Technology differences

Discrepancies in the level of technology used on a trail can be a major source of friction between trail users. Those hiking or using nonmotorized technologies such as cross-country skis tend to have more conflicts with users of motorized vehicles, such as snow machines, than vice versa. Recreational technologies such as mountain bikes and OHVs permit trail users to travel faster than pedestrians, who might complain of being startled by the sudden appearance and fast approach of these users. The speeds attained and the surface disturbance caused by motorized technologies can make hikers or those using a quiet mobility device such as a wheelchair feel threatened and overwhelmed. In general, the greater the difference in the level of technology used, the more likely the "low-tech" user will be to develop hostilities (Moore, 1994).

5.6.3.2 Movement patterns

Movement patterns vary significantly between user groups and is another potential source of trail conflict. Trail users travel at different speeds and require different amounts of space to move forward, stop, and turn. For example, skaters might occupy a larger width of trail than other users due to their kick-out propulsion method. Users who move at high speeds, e.g., snow machine users and bicyclists, require longer stopping and maneuvering distances. Those who use larger devices, such as OHVs or recumbent bicycles, also require more space to turn than pedestrians or wheelchair users, who are quite maneuverable. Sudden changes in direction can leave other trail users without sufficient time to react. Resulting collisions or near-misses can lead to hostilities. Separating different types of trail users (Figure 5-11), limiting speeds using design techniques such as shorter sight distances, and designing wider trails might mitigate movement pattern conflicts.

5.6.3.3 Perceived environmental impact

Perceived environmental disturbance also creates conflict between hikers and those who use recreation technologies to enjoy trails. Because equestrian, OHV, and mountain bike use can hasten erosion of soft surfaces so that they become more difficult to negotiate for other users (Cimarron Designs, 1994), hikers often perceive these groups as "ruining" trails or surrounding natural areas (Ryan, 1993). This perception, however, does not take into consideration the fact that hikers damage trails and soils as well.

The combined size and power of some trail users and their mode of transport can frighten or intimidate others. For example, a cross-country skier might feel that encounters with large, loud snow machines are unsafe and overwhelming (Moore, 1994). Conflicts between equestrians and other trail users can occur because horses are often skittish and can startle or bolt, creating a hazard for other trail users. Those unaccustomed to being around horses might unwittingly provoke them to bite, rear, or flee by petting or otherwise approaching them. Other trail users might feel threatened by the size or proximity of a horse.

5.6.3.4 New and newly popularized sports

People encountering an activity or technology for the first time on a trail can be suspicious and wary of the behavior, appropriateness, and demeanor of the newcomers. For example, new sports often attract young people; their boisterous behavior can often antagonize older trail users disturbed by the noise. When an activity such as in-line skating suddenly becomes popular, many people with little control over their speed and maneuverability appear on trails. The seemingly reckless and irresponsible behavior of novices often causes other trail users to develop negative stereotypes about those who practice the activity. New and newly popularized sports also tend to lack established standards of etiquette. As a result, those who encounter people using the new technology do not know how to react to the newcomers.

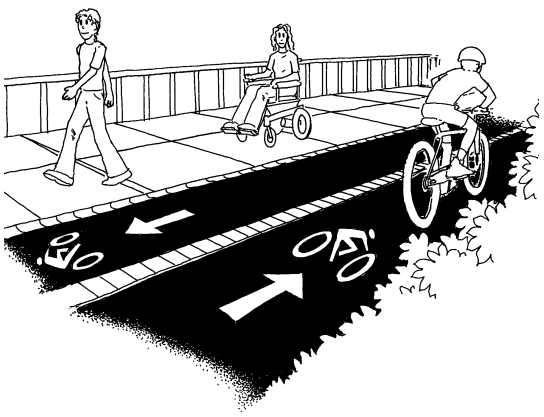
As more people participate in a new sport, other trail users gain experience interacting with the newcomers. As the new activity becomes established, etiquette standards become more widely known, followed, and understood by all trail users. For example, good trail-user ethics have recently been developed and publicized for mountain biking, a relatively new trail activity. Once learned by more users, these etiquette standards will help mitigate the conflicts between bikers and other trail users. Another method of blending new users into an established trail community is to encourage use of appropriate equipment and behavior in promotional programs (Moore, 1994).

5.6.4 Lack of Communication Among Trail Users

A lack of communication between different trail users is the root of many clashes and collisions on trails. Users must realize that communication is a two-way interaction and make an effort

Figure 5-11:

Separate pathways and clear signage can help reduce conflicts between users who travel at different speeds.



to warn others of their needs and intentions. For example, cyclists overtaking a pedestrian might communicate their approach through an audible signal such as their voice or a bell but might also opt to use hand and arm turning signals. For communication to be successful, those receiving the signal must understand its meaning. For instance, a person who is Deaf or hard of hearing might not detect the ringing of a bicycle bell, or some people might not understand that an outstretched, bent arm indicates a right turn. If trail users are schooled in a basic and universal system of communication, such as what ringing a bike bell means, chances for conflict and crashes are minimized. Signs, speed limits, and good user etiquette can also help minimize hostility between groups (Ryan, 1993).

5.6.5 Number of Users

The number of trail users will increase the chances of conflicts, regardless of the mix of user groups. For example, if backpackers seeking solitude encounter more users on the trail than expected, their frustration at being unable to find an uncrowded area might spur them to initiate a conflict with other users.

5.6.6 Minimizing User Conflicts on Trails

Promoting responsible behavior on trails can minimize user conflict. Trail etiquette standards can be publicized on trail signs (Figure 5-12) and in existing educational materials (Orwig, 1995). Trail users might be less likely to become offended at the actions of other people once they understand how each group is supposed to act. Trail users also might be less likely to violate an established code of behavior if they believe the rules will be enforced by trail personnel.

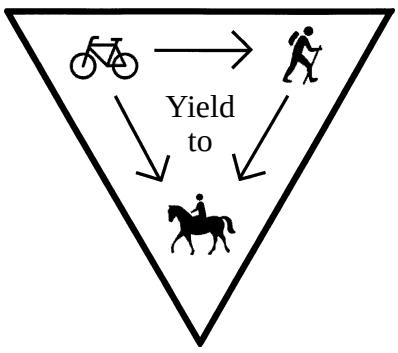


Figure 5-12:
Trail signs can help clarify trail etiquette.

Minimizing contact between conflicting types of trail users, especially in congested areas such as trailheads, can be the best method to avoid trail problems. Providing several entrances to a single trail, or several trails at a variety of difficulty levels, can help reduce conflicts between individual user types (Orwig, 1995). Trails that permit only trail users that have similar needs and expectations might have fewer incidences of user conflicts than trails that permit motorized users to mix with nonmotorized users. A good understanding of the needs and behavior of different groups is essential to make wise trail-use decisions.

Ultimately, trail managers must have a good understanding of the motivations, desired experiences, and points of view of various trail user groups (Moore, 1994). This information can help trail managers anticipate conflicts before they arise and identify solutions satisfactory to the majority of trail users. Trail managers can obtain information on existing conflicts and gather proposed solutions by meeting with individual user groups, including people with disabilities. These contacts can be used to call a negotiation meeting if conflicts arise in the future. Such a meeting can help all parties arrive at a consensus on how to address the problem.

Although eliminating all trail conflicts on very crowded or otherwise problematic trails might not be possible, conflict-mitigation techniques will usually help reduce the effects of such dilemmas.

5.7 Conclusion

Everyone should have the opportunity to experience and enjoy the natural environment. People with and without disabilities, older people, families, and children all benefit from being able to enjoy parks and forests. To the maximum extent feasible, trails should be designed to accommodate the access needs of all designated users. Considering accessibility when designing trails and installing accessible built facilities such as wheelchair-accessible toilets, Braille displays in visitor centers, and lowered drinking fountains will permit more people to enjoy the outdoors. In addition, providing detailed information about existing path conditions and available facilities can help visitors select trails. Such trail information reduces the likelihood that a trail user will become stranded or endangered and can improve safety and visitor enjoyment. Although increased use might be accompanied by increased conflicts between different types of trail users, land managers can minimize friction between groups by using good trail-management techniques.

Table 5-4.1:

Federal Accessibility Guidelines for Maximum Allowable Running Slope without Landings and Handrails

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
ADA Standards for Access. Design[1] (US DOJ,1991)	AR	5[2]			
UFAS (US DoD, et al., 1984)	AR	5[2]			

[1] The ADA Standards for Accessible Design are identical in content to ADAAG Sections 1–10. However, the Design Standards are enforceable by the U.S. Department of Justice.

[2] The ADA Standards for Accessible Design and UFAS both require people to use the least slope possible on accessible routes. An accessible route with a running slope greater than 5% is considered a ramp whose slope should be the least possible but may not exceed 8.33% (see Table 5-5.1).

Table 5-4.2:

Federal Advisory Committee Recommendations for Maximum Allowable Running Grade

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	ORAR		5	5	8
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	RT		5	8	12

Table 5-4.3:

Federal Guidelines for Maximum Allowable Running Grade

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	H		n/a	n/a	n/a
Guide for the Dev. of Bicycle Facilities (AASHTO, 1997, Draft)	S	5			
Guide for the Dev. of Bicycle Facilities (AASHTO, 1991)	B	5			
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	E		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	X		7.5	12	17
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	SM		8	n/a	15
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	ATV		15	25	35

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-4.4:

State, County, and City Guidelines for Maximum Allowable Running Grade

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
Klamath District's Trail. . . (Beers, 1993, Draft)	ORAR	5			
NM Plan for Accessible Fishing (Nordhaus, et al., 1984)	ORAR		5	6.3	8.33
Access to Parks Guidelines (CA State Parks, 1997)	RT		< 5	5	6.3
Ped. Facilities Guidebook for WA DOT (WA DOT, 1997)	RT		5	8.33	12.5
Alaska Region Trails Const. (USDA FS, AK Reg. FS, 1991)	H		n/a	n/a	n/a
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	H	10			
PA Plan for Nonmotorized Trails (PA Trials Pgm., 1980b)	H	10			
FL Bicycle Facilities Planning. . . (FL DOT. . ., 1997)	S	5			
Oregon Bicycle and Ped. Plan (OR DOT, 1995)	S	5			
Pitkin City Trails Dgn. and Mgt. . . . (Cimarron Designs, 1994)	S	5			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	B	15			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	B	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	B	5			
Wisconsin DNR Design Standards (WI DNR, 1994)	B	15			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	E	15			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	E	10			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	E	15			
Wisconsin DNR Design Standards (WI DNR, 1994)	E	15			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	X			8	17
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	SM	25			
Wisconsin DNR Design Standards (WI DNR, 1994)	SM	25			
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	ATV	75			
Wisconsin DNR Design Standards (WI DNR, 1994)	ATV	n/a			

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-4.5:

Additional Recommendations for Maximum Allowable Running Grade

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
ORAR and RT Design Specification (Axelson et al., 1995)[1]	ORAR		5	8	10
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	ORAR		5	5	8.33
ORAR and RT Design Specification (Axelson et al., 1995)[1]	RT		8	10	14
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	RT		5	8.33	12.5
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	H	15			
Trails for the 21st Century (Ryan, 1993)	S	5			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	B	10			
Trails for the 21st Century (Ryan, 1993)	B	8			
Mountain Bike Trails: Tech for. . . (McCoy and Stoner, 1992)	MB		5	10	15
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	E	10			
Trails for the 21st Century (Ryan, 1993)	E	10			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	X	10			
Trails for the 21st Century (Ryan, 1993)	X	5			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	SM	25			
Trails for the 21st Century (Ryan, 1993)	SM	n/a			
OHM and ATV Trails Guidelines for Dgn. . . . (Wemex, 1994)	ATV		8	12	15

[1] Maximum allowable average grade not running grade.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-5.1:

Federal Accessibility Guidelines for Maximum Slope for a Specified Ramp Run with Landings and Handrails

Source	Path Type	Single Level		Multiple Levels					
				Easier		Moderate		Difficult	
		Grade %	Run m	Grade %	Run m	Grade %	Run m	Grade %	Run m
ADA Standards for Access. Design (US DOJ,1991)	AR	8.33[1]	9.1						
UFAS (US DoD, et al., 1984)	AR	8.33[1]	9.1						

[1] ADA Standards for Accessible Design and UFAS both require people to use the least slope possible on accessible routes.

Table 5-5.2:

Federal Advisory Committee Recommendations for Maximum Grade for a Specified Distance (Run)

Source	Path Type	Single Level		Multiple Levels					
				Easier		Moderate		Difficult	
		Grade %	Run m	Grade %	Run m	Grade %	Run m	Grade %	Run m
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	ORAR			8	9.1	10	15.2	10	15.2
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	RT			10	9.1	14	15.2	20	15.2

Table 5-5.3:

Federal Guidelines for Maximum Grade for a Specified Distance (Run)

Source	Path Type	Single Level		Multiple Levels					
				Easier		Moderate		Difficult	
		Grade %	Run m	Grade %	Run m	Grade %	Run m	Grade %	Run m
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	H			20	30.5	30	91.4	+30	152.4
Guide for the Dev. of Bicycle Facilities (AASHTO, 1997, Draft)	S	+11	15						
Guide for the Dev. of Bicycle Facilities (AASHTO, 1991)	B	n/a	n/a						
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	E			15	61	25	91.4	+30	152.4
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	X			10	30.5	20	30.5	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	SM			25	n/a[1]	n/a	n/a	35	n/a[1]
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	ATV			20	61.0	30	91.4	50	152.4

[1] The requirement was for maximum pitch, no distance was specified.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-5.4:

State, County, and City Guidelines for Maximum Grade for a Specified Distance (Run)

Source	Path Type	Single Level		Multiple Levels					
				Easier		Moderate		Difficult	
		Grade %	Run m	Grade %	Run m	Grade %	Run m	Grade %	Run m
Klamath District's Trail. . . (Beers, 1993, Draft)	ORAR	8.33	9.1						
NM Plan for Accessible Fishing (Nordhaus, et al., 1984)	ORAR			8.33	9.1	8.33	9.1	8.33	9.1
Access to Parks Guidelines (CA State Parks, 1997)	RT			5	15.2	6.3	12.2	8.33	9.1
Ped. Facilities Guidebook for WA DOT (WA DOT, 1997)	RT			8.33	9.1	14	15.2	20	15.2
Alaska Region Trails Const. (USDA FS, AK Reg. FS, 1991)	H			20	30.5	30	91.4	+30	152.4
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	H	15	n/a[1]						
PA Plan for Nonmotorized Trails (PA Trials Pgm., 1980b)	H	20	n/a[2]						
FL Bicycle Facilities Planning. . . (FL DOT. . ., 1997)	S	11	15.2						
Oregon Bicycle and Ped. Plan (OR DOT, 1995)	S	8.33	9.1						
Pitkin City Trails Dgn. and Mgt. . . . (Cimarron Designs, 1994)	S	10	15.2						
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	B	30	152.4						
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	B	5	91.4						
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	B	n/a	n/a						
Wisconsin DNR Design Standards (WI DNR, 1994)	B	30	30.5						
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	E	25	30.5						
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	E	15	45.7						
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	E	n/a	n/a						
Wisconsin DNR Design Standards (WI DNR, 1994)	E	25	30.5						
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	X			n/a	n/a	10	n/a[1]	20	n/a[1]
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	SM	n/a	n/a						
Wisconsin DNR Design Standards (WI DNR, 1994)	SM	n/a	n/a						
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	ATV	n/a	n/a						
Wisconsin DNR Design Standards (WI DNR, 1994)	ATV	n/a							

[1] For short distances.

[2] In extreme circumstances, 20% is permitted. In general 15% should be observed as the maximum grade and should only be used over short distances.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-5.5:

Additional Recommendations for Maximum Grade for a Specified Distance Run

Source	Path Type	Single Level		Multiple Levels					
				Easier		Moderate		Difficult	
		Grade %	Run m	Grade %	Run m	Grade %	Run m	Grade %	Run m
ORAR and RT Design Specification (Axelson et al., 1995)	ORAR			8	3.0	12	9.1	14	9.1
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	ORAR			8.33	9.1	10	15.2	10	15.2
ORAR and RT Design Specification (Axelson et al., 1995)	RT			14	3.0	14	9.1	20	9.1
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	RT			10	15.2	14	15.2	20	15.2
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	H	40	45.7						
Trails for the 21st Century (Ryan, 1993)	S	8.0	9.1						
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	B	15	45.7						
Trails for the 21st Century (Ryan, 1993)	B	n/a	n/a						
Mountain Bike Trails: Tech for. . . (McCoy and Stoner, 1992)	MB			10	30.5	30	91.4	+30	152.4
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	E	20	45.7						
Trails for the 21st Century (Ryan, 1993)	E	n/a	n/a						
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	X	40	45.7						
Trails for the 21st Century (Ryan, 1993)	X	n/a	n/a						
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	SM	40	45.7						
Trails for the 21st Century (Ryan, 1993)	SM	n/a	n/a						
OHM and ATV Trails Guidelines for Dgn. . . . (Wemex, 1994)	ATV			15	n/a	30	n/a	50	n/a

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-6.1:

Federal Accessibility Guidelines for Maximum Allowable Running Cross-Slope

	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
Source		%	%	%	%
ADA Standards for Access. Design (US DOJ,1991)	AR	2[1]			
UFAS (US DoD, et al., 1984)	AR	2[1]			

[1] ADA Standards for Accessible Design and UFAS both require people to use the least slope possible on accessible routes.

Table 5-6.2:

Federal Advisory Committee Recommendations for Maximum Allowable Running Cross-Slope

	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
Source		%	%	%	%
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	ORAR		3	3	3
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	RT		3	5	8

Table 5-6.3:

Federal Guidelines for Maximum Allowable Running Cross-Slope

	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
Source		%	%	%	%
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	H		n/a	n/a	n/a
Guide for the Dev. of Bicycle Facilities (AASHTO, 1997, Draft)	S	2			
Guide for the Dev. of Bicycle Facilities (AASHTO, 1991)	B	2			
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	E		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	X		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	SM		15	30	40
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	ATV		20	30	40

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-6.4:

State, County, and City Guidelines for Maximum Allowable Running Cross-Slope

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
Klamath District's Trail. . . (Beers, 1993, Draft)	ORAR	1			
NM Plan for Accessible Fishing (Nordhaus, et al., 1984)	ORAR		2	3.3	5
Access to Parks Guidelines (CA State Parks, 1997)	RT		1	2	n/a
Ped. Facilities Guidebook for WA DOT (WA DOT, 1997)	RT		2	3	5
Alaska Region Trails Const. (USDA FS, AK Reg. FS, 1991)	H		n/a	n/a	n/a
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	H	n/a			
PA Plan for Nonmotorized Trails (PA Trials Pgm., 1980b)	H	n/a			
FL Bicycle Facilities Planning. . . (FL DOT. . ., 1997)	S	2			
Oregon Bicycle and Ped. Plan (OR DOT, 1995)	S	2			
Pitkin City Trails Dgn. and Mgt. . . (Cimarron Designs, 1994)	S	2			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	B	n/a			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	B	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	B	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	B	n/a			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	E	n/a			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	E	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	E	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	E	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	X		n/a	n/a	n/a
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	SM	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	SM	n/a			
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	ATV	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	ATV	n/a			

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-6.5:

Additional Recommendations for Maximum Allowable Running Cross-Slope

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		%	%	%	%
ORAR and RT Design Specification (Axelson et al., 1995)[1]	ORAR		3	5	8
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	ORAR		3	3	3
ORAR and RT Design Specification (Axelson et al., 1995)[1]	RT		5	8	12
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	RT		3	5	8.33
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	H	4			
Trails for the 21st Century (Ryan, 1993)	S	2			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	B	4			
Trails for the 21st Century (Ryan, 1993)	B	4			
Mountain Bike Trails: Tech for. . . (McCoy and Stoner, 1992)	MB		n/a	n/a	n/a
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	E	4			
Trails for the 21st Century (Ryan, 1993)	E	4			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	X	2			
Trails for the 21st Century (Ryan, 1993)	X	4			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	SM	2			
Trails for the 21st Century (Ryan, 1993)	SM	n/a			
OHM and ATV Trails Guidelines for Dgn. . . . (Wemex, 1994)	ATV		n/a	n/a	n/a

[1] Maximum allowable average cross-slope not running cross-slope.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-7.1:

Federal Accessibility Guidelines for Minimum Clearance Width

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
ADA Standards for Access. Design (US DOJ,1991)	AR	0.915			
UFAS (US DoD, et al., 1984)	AR	0.915			

Table 5-7.2:

Federal Advisory Committee Recommendations for Minimum Clearance Width

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	ORAR		1.220	0.915	0.915
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	RT		1.220	0.915	0.760

Table 5-7.3:

Federal Guidelines for Minimum Clearance Width

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	H		n/a	n/a	n/a
Guide for the Dev. of Bicycle Facilities (AASHTO, 1997, Draft)	S	n/a			
Guide for the Dev. of Bicycle Facilities (AASHTO, 1991)	B	n/a			
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	E		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	X		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	SM		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	ATV		n/a	n/a	n/a

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-7.4:

State, County, and City Guidelines for Minimum Clearance Width

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
Klamath District's Trail. . . (Beers, 1993, Draft)	ORAR	1.525			
NM Plan for Accessible Fishing (Nordhaus, et al., 1984)	ORAR		0.915	0.915	0.815
Access to Parks Guidelines (CA State Parks, 1997)	RT		0.915	0.915	n/a
Ped. Facilities Guidebook for WA DOT (WA DOT, 1997)	RT		1.2	.9	0.7
Alaska Region Trails Const. (USDA FS, AK Reg. FS, 1991)	H		n/a	n/a	n/a
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	H	n/a			
PA Plan for Nonmotorized Trails (PA Trials Pgm., 1980b)	H	n/a			
FL Bicycle Facilities Planning. . . (FL DOT. . ., 1997)	S	n/a			
Oregon Bicycle and Ped. Plan (OR DOT, 1995)	S	n/a			
Pitkin City Trails Dgn. and Mgt. . . . (Cimarron Designs, 1994)	S	n/a			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	B	n/a			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	B	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	B	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	B	n/a			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	E	n/a			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	E	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	E	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	E	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	X		n/a	n/a	n/a
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	SM	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	SM	n/a			
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	ATV	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	ATV	n/a			

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-7.5:

Additional Recommendations for Minimum Clearance Width

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
ORAR and RT Design Specification (Axelson et al., 1995)	ORAR		0.915	0.815	0.710
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	ORAR		1.220[2]	0.915[2]	0.915[2]
ORAR and RT Design Specification (Axelson et al., 1995)	RT		1.220	0.915	0.710
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	RT		1.220	0.915	0.710
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	H	n/a			
Trails for the 21st Century (Ryan, 1993)	S	.815[1]			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	B	n/a			
Trails for the 21st Century (Ryan, 1993)	B	n/a			
Mountain Bike Trails: Tech for. . . (McCoy and Stoner, 1992)	MB		n/a	n/a	n/a
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	E	n/a			
Trails for the 21st Century (Ryan, 1993)	E	n/a			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	X	n/a			
Trails for the 21st Century (Ryan, 1993)	X	n/a			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	SM	n/a			
Trails for the 21st Century (Ryan, 1993)	SM	n/a			
OHM and ATV Trails Guidelines for Dgn. . . . (Wemex, 1994)	ATV		n/a	n/a	n/a

[1] For reasonably short distances, 0.815 m is permitted.

[2] For distances less than 0.610 m, 0.815 m is permitted.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-8.1:

Federal Accessibility Guidelines for Vertical Changes in Level

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		mm	mm	mm	mm
ADA Standards for Access. Design (US DOJ,1991)	AR	6[1]			
UFAS (US DoD, et al., 1984)	AR	6[1]			

[1] Changes in level between 6 and 13 mm must be beveled with a maximum slope of 50 percent. Changes in level greater than 13 mm must be treated with a ramp, curb ramp, or elevator.

Table 5-8.2:

Federal Advisory Committee Recommendations for Vertical Changes in Level

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		mm	mm	mm	mm
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	ORAR		13	13	25
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	RT		13	13	25

Table 5-8.3:

Federal Guidelines for Vertical Changes in Level

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		mm	mm	mm	mm
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	H		n/a	n/a	n/a
Guide for the Dev. of Bicycle Facilities (AASHTO, 1997, Draft)	S	n/a			
Guide for the Dev. of Bicycle Facilities (AASHTO, 1991)	B	n/a			
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	E		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	X		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	SM		n/a	n/a	n/a
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	ATV		n/a	n/a	n/a

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-8.4:

State, County, and City Guidelines for Vertical Changes in Level

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		mm	mm	mm	mm
Klamath District's Trail. . . (Beers, 1993, Draft)	ORAR	n/a			
NM Plan for Accessible Fishing (Nordhaus, et al., 1984)	ORAR		6	13	n/a
Access to Parks Guidelines (CA State Parks, 1997)	RT	6			
Ped. Facilities Guidebook for WA DOT (WA DOT, 1997)	RT		13	26	76
Alaska Region Trails Const. (USDA FS, AK Reg. FS, 1991)	H		n/a	n/a	n/a
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	H	n/a			
PA Plan for Nonmotorized Trails (PA Trials Pgm., 1980b)	H	n/a			
FL Bicycle Facilities Planning. . . (FL DOT. . ., 1997)	S	n/a			
Oregon Bicycle and Ped. Plan (OR DOT, 1995)	S	6			
Pitkin City Trails Dgn. and Mgt. . . . (Cimarron Designs, 1994)	S	n/a			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	B	n/a			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	B	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	B	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	B	n/a			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	E	n/a			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	E	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	E	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	E	n/a			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	X		n/a	n/a	n/a
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	SM	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	SM	n/a			
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	ATV	n/a			
Wisconsin DNR Design Standards (WI DNR, 1994)	ATV	n/a			

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-8.5:

Additional Recommendations for Vertical Changes in Level

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		mm	mm	mm	mm
ORAR and RT Design Specification (Axelson et al., 1995)	ORAR		13	25	50
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	ORAR		13	13	25
ORAR and RT Design Specification (Axelson et al., 1995)	RT		25	50	100
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	RT		13[1]	25[1]	75[1]
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	H	n/a			
Trails for the 21st Century (Ryan, 1993)	S	n/a			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	B	n/a			
Trails for the 21st Century (Ryan, 1993)	B	n/a			
Mountain Bike Trails: Tech for. . . (McCoy and Stoner, 1992)	MB	n/a			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	E	n/a			
Trails for the 21st Century (Ryan, 1993)	E	n/a			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	X	n/a			
Trails for the 21st Century (Ryan, 1993)	X	n/a			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	SM	n/a			
Trails for the 21st Century (Ryan, 1993)	SM	n/a			
OHM and ATV Trails Guidelines for Dgn. . . . (Wemex, 1994)	ATV		n/a	n/a	n/a

[1] Changes in level greater than 6 mm must be beveled with a 1:2 slope.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-9.1:

Federal Accessibility Guidelines for Vertical Clearance (Head Room)

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
ADA Standards for Access. Design (US DOJ,1991)	AR	2.030			
UFAS (US DoD, et al., 1984)	AR	2.030			

Table 5-9.2:

Federal Advisory Committee Recommendations for Vertical Clearance

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	ORAR		2.030	2.030	2.030
Recommendations for Accessibility Guidelines: Recreational Facilities. . . (Rec. Access. Adv. Comm., 1994)	RT		2.030	2.030	2.030

Table 5-9.3:

Federal Guidelines for Vertical Clearance

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	H		2.440	2.440	2.440
Guide for the Dev. of Bicycle Facilities (AASHTO, 1997, Draft)	S	2.5			
Guide for the Dev. of Bicycle Facilities (AASHTO, 1991)	B	2.440			
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	E		3.050	2.440	2.440
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	X		1.830	1.830	1.830
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	SM		2.135[1]	2.135[1]	2.135[1]
USDA FS Trails Mgt. Handbook (USDA FS, 1985)	ATV		1.830	1.830	1.525

[1] Above-average snow level.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-9.4:

State, County, and City Guidelines for Vertical Clearance

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
Klamath District's Trail. . . (Beers, 1993, Draft)	ORAR	2.440			
NM Plan for Accessible Fishing (Nordhaus, et al., 1984)	ORAR		2.030	2.030	2.030
Access to Parks Guidelines (CA State Parks, 1997)	RT		2.135	2.135	2.135
Ped. Facilities Guidebook for WA DOT (WA DOT, 1997)	RT		n/a	n/a	n/a
Alaska Region Trails Const. (USDA FS, AK Reg. FS, 1991)	H		2.440	2.440	2.440
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	H	2.135			
PA Plan for Nonmotorized Trails (PA Trials Pgm., 1980b)	H	2.440			
FL Bicycle Facilities Planning. . . (FL DOT. . ., 1997)	S	2.4			
Oregon Bicycle and Ped. Plan (OR DOT, 1995)	S	2.4			
Pitkin City Trails Dgn. and Mgt. . . . (Cimarron Designs, 1994)	S	3.050			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	B	3.050			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	B	2.440			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	B	2.440			
Wisconsin DNR Design Standards (WI DNR, 1994)	B	3.050			
KY Dept. of Parks Trail Construction. . . (KY Dept. of Parks, 1989)	E	3.050			
MO St. Parks Trail Const. Guidelines (MO DNR, 1975)	E	2.440			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	E	3.050			
Wisconsin DNR Design Standards (WI DNR, 1994)	E	3.660			
PA Plan for Nonmotorized Trails (PA Trails Pgm., 1980b)	X			2.440[1]	2.440[1]
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	SM	2.440[1]			
Wisconsin DNR Design Standards (WI DNR, 1994)	SM	3.660[1]			
PA Plan for Motorized Trails (PA Trails Pgm., 1980a)	ATV	2.440[2]			
Wisconsin DNR Design Standards (WI DNR, 1994)	ATV	3.660[2]			

[1] Above-average snow level.

[2] Above trail surface.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail

Table 5-9.5:

Additional Recommendations for Vertical Clearance

Source	Path Type	Single Level	Multiple Levels		
			Easier	Moderate	Difficult
		m	m	m	m
ORAR and RT Design Specification (Axelson et al., 1995)	ORAR		n/a	n/a	n/a
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	ORAR		2.030	2.030	2.030
ORAR and RT Design Specification (Axelson et al., 1995)	RT		n/a	n/a	n/a
Universal Access. to Outdoor Rec. (PLAE, Inc., 1993)	RT		2.030	2.030	2.030
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	H	2.440			
Trails for the 21st Century (Ryan, 1993)	S	3.050			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	B	2.440			
Trails for the 21st Century (Ryan, 1993)	B	2.135			
Mountain Bike Trails: Tech for. . . (McCoy and Stoner, 1992)	MB		2.440	2.440	2.440
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	E	3.050			
Trails for the 21st Century (Ryan, 1993)	E	3.050			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	X	2.440			
Trails for the 21st Century (Ryan, 1993)	X	2.135[1]			
Recreational Trail Design and Const. (Rathke and Baughman, 1994)	SM	2.440			
Trails for the 21st Century (Ryan, 1993)	SM	3.050			
OHM and ATV Trails Guidelines for Dgn. . . . (Wemex, 1994)	ATV		2.740	2.440	2.440

[1] Above-average snowfall.

AR = Accessible Route
H = Hiking Trail
MB = Mountain Biking Trail
SM = Snow Machine Trail
OHV = Off-Highway Vehicle Trail
ORAR = Outdoor Recreation Access Route
S = Shared-Use Path
E = Equestrian Trail
ATV = All-Terrain Vehicle Trail
M = Motorcycle Trail
RT = Recreational Trail
B = Bicycle Path
X = Cross-Country Ski Trail